National Aeronautics and Space Administration

Biodigester Feasibility and Design for Space & Earth

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HAT: 6.1a-E TA: 6.1 – Closed Loop, High-Reliability, Life Support Systems TRL: start 2 / current 4

ICA PROJECT OVERVIEW

Anaerobic digestion converts organic waste into methane gas and fertilizer effluent. The ICA-developed prototype system is designed for planetary surface operation. It uses passive hydrostatic control for reliability, and is modular and redundant. The serpentine configuration accommodates tight geometric constraints similar to the ISS ECLSS rack architectures. Its shallow, low-tilt design enables (variable) lower-g convection than standard Earth (1 g) digesters. This technology will reuse and recycle materials including human waste, excess food, as well as packaging (if biodegradable bags are used).

INNOVATION

Biogas technology is a viable option for reducing waste with the added benefit of creating fertilizer to close the loop on soil requirements for Veggie or other potentially independent and self-sustaining agricultural systems. It will enable long-term, sustainable missions by reducing dependence on Earth-based resources.

OUTCOME / RESULTS

- Feasible prototype with a lower cost-of-operation due to its usage of available onsite cattle manure.
- Modular, redundant, and flexible system designed for planetary surface operation, featuring all passive control for reliability.

INFUSION FOR SPACE / EARTH

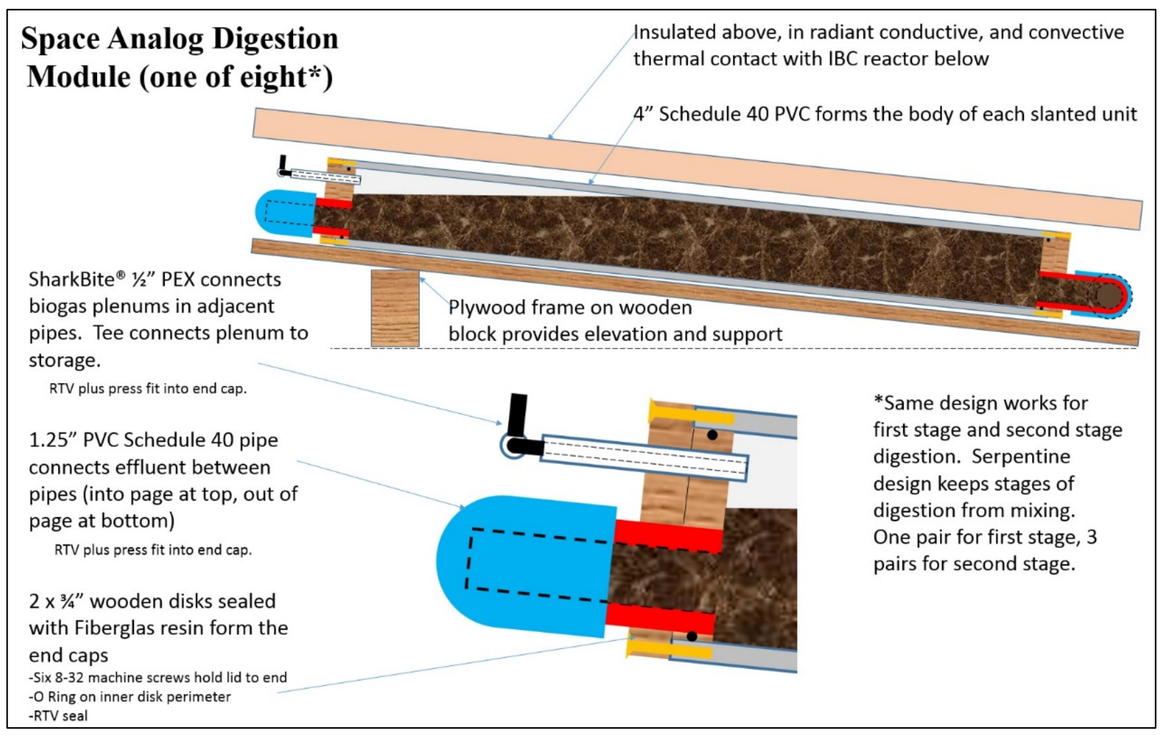
- Currently used by households, industry, schools
- Comparative functions to the Trash-to-Gas technology for waste management techniques on planetary surfaces

PAPERS / PRESENTATIONS

“Biogasification Studies for the Johnson Space Center: High Solids Anaerobic Digestion Technologies” (2010) was referenced. The authors’ feedback included reducing the size of the system for transport.

2016 IR&D Poster – EISD Technology Showcase

PICTURE OF ICA DEVELOPED PROTOTYPE



PARTNERSHIPS / COLLABORATIONS

This technology has never been demonstrated at JSC. In addition to investigating a gap in Journey to Mars technology, it benefits three key partners:
1. The Sustainability Partnerships Team, which identifies projects to deliver environmental benefits to both space and Earth applications.
2. The Longhorn Project, which educates students and seeks to integrate more closely with NASA.
3. Engineers Without Borders – JSC (EWB-JSC), which provided the majority of the engineering design work. JSC benefitted from their expertise and conjunctive anaerobic digestion work in a remote setting. EWB benefitted by gaining direct biogas technology experience for 3rd world applications.

Engineers and researchers collaborated to investigate biogas in relation to current technology and other systems expected on Mars. Cost-sharing methods also contribute greatly to strengthen the project’s viability.

FUTURE WORK

The operational phase will effectively use digester byproducts (i.e. gas and effluent). Additionally, sensor systems are being developed to remotely monitor operation and gas output to optimize system efficiency. Finally, human factors concepts will also be applied to improve routine bio-digester operations.